

DOCUMENT RESUME

ED 196 417

IR 009 021

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 TITLE Simulating CBE on Paper: A Small Step Backwards.
 SPONS AGENCY National Institutes of Health (DHEW), Bethesda, Md.
 Bureau of Health Professions Education and Manpower
 Training.
 PUB DATE 80
 GRANT 1-D12-AH-90110
 NOTE 15p.: Paper presented at the Annual Meeting of the
 American Educational Research Association (Boston,
 MA, April 1980).
 EDRS PRICE MF01/PC01 Plus Postage.
 DESCRIPTORS *Comparative Analysis; *Computer Assisted
 Instruction; Higher Education; Instructional
 Materials; *Intermode Differences; *Paper
 (Material)
 IDENTIFIERS *PLATO

ABSTRACT

A study was conducted in the School of Medical Technology at the University of Illinois to determine the relative learning effectiveness of lessons taught by means of computer assisted instruction (in this case, PLATO) versus lessons taught by means of paper copies adapted from the PLATO system. While the benefits of translating paper instructional materials to computer systems have been explored, little attention has been given to using the computer to generate paper instructional materials. This study included three phases: (1) the steps involved and costs of translation of computer based information to paper copy were recorded and subjected to a feasibility analysis; (2) the translated instructional modules were evaluated for lesson style, content, and appropriateness; and (3) the short and long term learning effectiveness of PLATO lessons versus their paper counterparts were compared in a controlled study. The translation process was found to be feasible and students appeared to learn as effectively with the paper versions as with online delivery. Tables of data are included. (Author/LLS)

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ED196417

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SIMULATING CBE ON PAPER:

A SMALL STEP BACKWARDS

by

Lisa P. Brenner

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Simulating CBE on Paper: A Small Step Backwards *

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ABSTRACT

While the benefits of translating paper instructional materials to computer systems have been explored, little attention has been given to using the computer to generate paper instructional materials. This paper describes the translation and evaluation of 20 PLATO instructional programs in medical laboratory science. The costs and procedures of the translation process are described; reviews by educators in medical laboratory science for style, content, and format are summarized; and a study comparing the short and long term learning differences between the PLATO and paper medium is presented. The translation process was found to be feasible and students appeared to learn as effectively with the paper versions as with on-line delivery. Educators responded positively to the paper versions but were found to assign PLATO lessons more frequently than their paper counterparts.

OBJECTIVES

A three year grant from HEW has supported a project to provide educational resource sharing to a consortium of 22 Schools of Medical Technology. One aspect of this service is to provide PLATO based instructional materials to the schools, and to assist them in developing and sharing their own self-instructional materials. At our disposal are more than 120 PLATO instructional programs on subjects related to the field of medical technology. Since one third of the consortium members do not have PLATO system access, one of our goals has been to produce and distribute paper versions of selected self-instructional materials available on PLATO.

We first attempted to identify the feasibility of translating PLATO materials to paper. Members also wanted advice about the learning advantages of using PLATO within their educational programs, so a study was designed to provide them with advice directly relating to their instructional needs and options.

*This work was supported in part by the National Institute of Health, Bureau of Health Manpower Grant # 1-D12-AH-90110.

BACKGROUND

Comparisons of computer delivery with traditional methods of instruction have generally been equivocal, and on the whole negate one another. There is usually a bias in favor of any "new" treatment because improvements in lesson content accompany the development process (Jamison, 1974). Thus studies in which programed instruction is translated to a computer usually favor the computer application. There appear to be no studies examining the reverse procedure: transferring computer based information to paper copy, or attempting to hold content and style constant during the translation process. Computer based instruction, particularly on PLATO is subject to a different kind of review and revision process than is typical of programmed instruction. This process in itself can result in superior materials. (Brenner, 1979)

Dare (1976) compared the effectiveness of conventional training with that of computer based instruction. The two sets of instructional materials were developed independently from a common list of objectives. He allowed style to vary in order to utilize the unique advantages of each method. The enthusiasm and creativity of the developers was not controlled, however. His findings supported the educational advantages of computer based instruction. The feasibility analysis concluded that while the PLATO IV system was cost effective for development of instructional materials, communication costs made it not cost effective as a delivery system.

Students, even those familiar with PLATO, have repeatedly been observed to take more time completing instructional material on PLATO than on paper (Murphy, 1977). This phenomena is usually interpreted as a disadvantage, and has been a source of student complaints. It might indicate a more thorough initial processing of information by the student, resulting result in greater long term learning for material presented on PLATO than on paper. Some support for long-term learning effects was found in Physics at the University of Illinois where students who completed an introductory course on PLATO were found to score higher in subsequent physics courses than students with comparable grades completing the traditional course.

METHOD

The evaluation included three phases: 1) The steps involved and costs of translation were recorded and subjected to a feasibility analysis; 2) The translated instructional modules were submitted to the Education Coordinators at member schools for evaluation of lesson style, content, and appropriateness. 3) The short and long-term learning effectiveness of PLATO lessons vs. their paper counterparts were compared in a controlled study. These phases and results are reported in order, followed by general conclusions.

The Translation Process:

From a pool of 120 PLATO lessons appropriate to medical laboratory science, 20 lessons were selected for translation. Approximately 85% of the lessons reviewed were linear in format and could be easily translated to paper.

Two lessons from 10 disciplines were selected. Case studies, problem sets, introductory and advanced material, and reviews were included; some lessons emphasized graphics, others did not. Most selected lessons represented highly used materials which had been available on PLATO for a number of years, and had been subjected to the process of review and revision during this time. Each was created by a different author(s), and the set represented a variety of institutions.

Screen copies were made of selected lessons, preserving the exact format. Although the PLATO terminal can present an amount of information comparable to a page of text, user pressure has led to a general restriction on the amount of text presented per screen. This stylistic convention was retained in the paper copies, resulting in text with considerably less redundancy than in standard print. To duplicate the movement possible on the computer display, serial prints of animations were incorporated in the paper versions. Where it was necessary to emphasize subtle changes in diagrams, the prints were accordingly modified to prevent confusion.

A latent imaging format was used in the original translation process. After the review phase, it became apparent that this logistically awkward process was not feasible for implementation in our environment. The paper versions were reformatted to provide answer keys at the end of the instruction. The answer key replicated feedback presented in the lesson for correct and incorrect responses. Small changes were required in the directions. In all other respects, every effort was made to preserve the original display format.

The translation process required the services of an individual who was familiar with the content and PLATO. Attempts to use less trained personnel failed. A lesson averaged 30 pages and took approximately 2 hours to translate. Those which involved reformatting animations took at least twice that time, and the results were not always completely satisfactory.

Results: Screen copies can be made from the computer display, and these copies can be quickly assembled, into paper versions with few modifications. About ten percent of PLATO lessons are difficult to translate because they rely heavily on animated sequences modified on the basis of student interaction.

No matter how effective translated materials might be, it became apparent that computer delivery, even on PLATO may now be cost effective. The cost of duplicating paper materials equaled the cost of providing them online for PLATO sites at larger schools which use their PLATO terminals at least 40 hours a week. The overhead in dealing with paper is both exasperating and expensive. While the student may find paper versions more convenient because they may be taken home, the instructor is required to spend extra time and money to support that convenience. Lesson revisions also become more expensive and time consuming, particularly when a large number of schools are involved.

Expert Reviews:

Each association member was asked to review at least one of the twenty translated instructional modules, and to provide comments on their content, style, and appropriateness within the member's medical technology course. On the whole, the translated lessons were rated very favorably. A few criticisms appeared to derive from their origins as PLATO modules. Uneven content coverage was mentioned a number of times. This is a characteristic of many PLATO lessons, particularly when the relationship between textual primary presentation and PLATO presentation has not been clearly defined.

Most reviewers indicated that the modules would be valuable for review purposes, supporting the PLATO development emphasis on review applications. It is possible that the paper mode allows for a linear analysis which is difficult on a medium which lends itself to modular treatment. Thus, the paper translation process could be a useful tool in evaluating the completeness of lessons which ultimately reside on a computer system.

Reviews of the translated materials' style was equated with the mode of questioning used within the modules. More interaction, particularly on the higher cognitive levels was frequently called for. Subjectively, lessons translated from PLATO to paper appeared trivialized and less interactive. Some translated animations were criticized as being inappropriate to the paper medium.

Results: Despite favorable reviews and an enthusiastic response, six months after receiving the translated modules, member schools have not used them as a part of their instruction. In contrast, those schools with access to PLATO have made regular use of the same materials on-line. Our informal discussions indicate that the logistics of providing paper copies to students have delayed their use. Education coordinators feel that printed modules must conform exactly to their curriculums, stating that they want to revise the printed modules before using them. The same coordinators are having their students use the modules as is on PLATO. It appears that they consider computers to be a less formal medium than paper.

Learning Effectiveness:

Materials: The PLATO lessons discussed above were divided into two groups balanced by subject, lesson length, and style. Objective evaluation questions were selected for each lesson, with approximately one question for each five pages of instruction. Half of the items were taken from the instructional modules and half were taken from a bank of test items used by member schools. Items reflected standard testing practices and were not particularly oriented toward processes or higher cognitive levels. Attitude and experience questions were also included covering computer based and programmed instruction. The 102 items were used to construct a paper-delivered pretest, series of post tests, and a retention test.

Subjects: Twenty upper-level life science students were recruited from the University of Illinois, a pool from which medical laboratory science students are drawn. All subjects were familiar with the PLATO system and had positive attitudes to both programmed instruction and PLATO.

These attitudes were not perceptibly changed during the course of the experiment. One student dropped out during the experiment and was not replaced.

Method: All subjects received the pretest before beginning instruction and a retention test five days after completing the instruction. Subjects were arbitrarily divided into two groups, receiving half their instruction on PLATO each day and half in the translated lessons. Nine lessons were delivered to Group 1 on PLATO while Group 2 was given the paper counterpart. The second group of lessons was delivered in reverse format.

Subjects spent two hours a day for five days going through Plato and paper instructional modules. Each day they reversed the mode with which they began study. A quiz was administered each day over the previous day's work. Students were allowed to work at their own pace, but were encouraged to spend approximately 30 minutes on each instructional lesson. Notes were allowed, but were kept at the experimental facility in order to identify total study time.

Results: Although study time was longer for students working on PLATO lessons, it was not significantly so (Table 1). Time was an overwhelming factor in total retention for both PLATO and paper modes (Table 2) particularly with the more complex and graphic lesson material. Neither short term nor long term learning, adjusted by pretest scores, was significantly affected by PLATO vs. paper delivery (Table 3,4). Even lessons using graphics and animation were equally effective on paper as on PLATO (Table 5). A regression analysis supported the finding that time on task and pretest scores were the contributors to differences (Table 6).

Thus it appears that these medical laboratory science lessons may be used as effectively in their paper format as delivered on PLATO. Insofar as PLATO leads students to study longer on complex material, it may be a more desirable medium.

Conclusions

This project was begun with the expectation that PLATO lessons could be easily translated into paper instruction, and that the resulting product would be more cost-effective and convenient than computer delivery. While the materials were easily translated, the costs of duplication and handling have not made paper modules more desirable or used than computer delivered instruction. Medical Laboratory Science educators at this time appear to have a bias in favor of using the computer for supplementary instruction. In our environment, where many schools are sharing instructional resources, it would thus appear that the computer will remain the main medium of delivery, although paper publication of instructional materials developed on PLATO will be seriously considered as a revenue source.

The study assumed that students would spend more time studying the PLATO lessons than their paper counterparts. This was not confirmed on a significant level, but the learning value of time on task was supported. Neither short nor long term learning of subjects was significantly affected by the delivery medium. Lessons heavily utilizing animations and graphics were not more effective when delivered on PLATO, but extra study time

payed off well in this mode. Traditional evaluation methods were used and may not have been measuring higher level understandings which may have differed with a process oriented approach to evaluation. This study, however, was concerned with an applied problem in an existing education setting. It would be beyond our objectives to persue the problem further.

The effect of computer "interaction" with the student did not appear to dramatically impact learning. The paper versions of PLATO lessons differ notably from typical programmed instruction. The student is not controlled in a path through the instruction. A given page contains a relatively small amount of information, and graphics are used extensively. These stylistic conventions may be accounting for much of the learning facilitation attributed to computer interaction.

TABLE 1

ANOVA
INSTRUCTIONAL TIME

Total Lesson Set

	n	Mean	sd	
Hours to Complete Material on PLATO	19	4.06	.978	
Hours to Complete Material on Paper	19	3.72	.663	t(36)=1.254 p=.2178

Six Graphic Lessons

Hours to Complete Material on PLATO	19	1.64	.422	
Hours to Complete Material on Paper	19	1.35	.320	t(36)=2.425 p=.0208

TABLE 2

ANOVA
TIME VS RETENTION

PLATO and PAPER Lessons:				
	n	Mean	sd	
Hours to Complete	38	3.92	.855	
Material				
Retention	38	32.76	6.402	t(37)=27.042 p<.00005
% of Variance Accounted for in the sample:				95.2%
% of Variance Accounted for in the population:				95.1%
-PLATO Lessons:				
	n	Mean	sd	
Hours to Complete	19	4.06	.978	
Material				
Retention	19	33	6.51	t(18)=18.211 p<.00005
% of Variance Accounted for in the sample:				94.9%
% of Variance Accounted for in the population:				94.6%
FAPER Lessons:				
	n	Mean	sd	
Hours to Complete	19	3.77	.71	
Material				
Retention	19	32.53	6.46	t(18)=19.602 p<.00005
% of Variance Accounted for in the sample:				95.5%
% of Variance Accounted for in the population:				95.3%
PLATO Graphic Lessons:				
	n	Mean	sd	
Hours to Complete	19	1.64	.422	
Material				
Retention	19	10.95	1.48	t(18)=20.243 p<.00005
% of Variance Accounted for in the sample:				95.8%
% of Variance Accounted for in the population:				95.6%
Paper Graphic Lessons:				
	n	Mean	sd	
Hours to Complete	19	1.34	.325	
Material				
Retention	19	11.74	1.33	t(18)=31.62 p<.00005
% of Variance Accounted for in the sample:				98.2%
% of Variance Accounted for in the population:				98.1%

TABLE 3
ANOVA
Retention
With Scores Adjusted by Covariance

Predictor Scores	n	Mean	sd
PLATO	19	15.31	3.18
Paper	19	17.31	4.24
Retention Scores			
PLATO	19	33.00	6.31
Paper	19	32.52	6.45

Test for Difference in Predictor Scores: $t(36)=-1.644$ $p=.1089$

Test for Difference in Retention Scores: $t(36)=.2251$ $p=.8232$

Covariance test for equal regression $F(1,34)=.023$ $p=.88$

Adjusted Mean Retention Scores:

PLATO	33.49	
Paper	32.03	$p=.496$
		$F(1,35)=.471425$

TABLE 4

ANOVA
Post-tests
With Scores Adjusted by Covariance

Predictor Scores	n	Mean	sd
PLATO	18	15.66	2.86
Paper	18	17.38	4.35
Post-test Scores			
PLATO	18	33.5	6.94
Paper	18	32.05	6.24

Test for Difference in Predictor Scores: $t(34)=-1.401$ $p=.1702$

Test for Difference in Post-test Scores: $t(34)=-.656$ $p=.5162$

Covariance test for equal regression $F(1,32)=.235$ $p=.635$

Adjusted Mean Post-test Scores:

PLATO	34.026
Paper	31.529 $p=.256$
	$F(1,33)=1.33607$

TABLE 5

ANOVA
Retention on Six Graphic Lessons
With Scores Adjusted by Covariance

Predictor Scores	n	Mean	sd
PLATO	19	6.316	1.796
Paper	19	6.236	2.400
Retention Scores			
PLATO	19	10.95	1.78
Paper	19	11.74	1.33

Test for Difference in Predictor Scores: $t(36)=-.7652$ $p=.939$

Test for Difference in Retention Scores: $t(36)=1.551$ $p=.1297$

Covariance test for equal regression $F(1,34)=2.202$ $p=.1468$

Adjusted Mean Retention Scores:

PLATO	10.947
Paper	11.736 $p=.135$
	$F(1,35)=2.33815$

TABLE 6

Regression Analysis
PLATO Instruction VS Paper Instruction

	Eigenvalues	% of Trace
Time:	1730	79.31
Pre Test Score:	425.2	19.5
Retention:	26.09	1.196

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